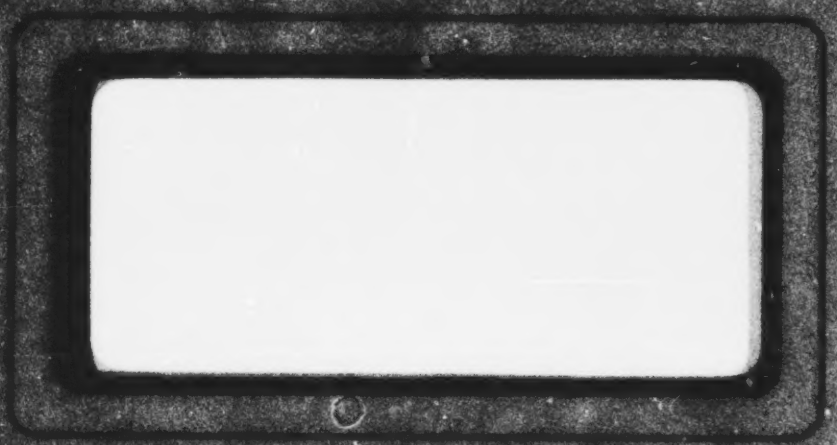

THE 1984 EURASIAN WATER MILFOIL SURVEILLANCE AND CONTROL PROGRAM IN SHUSWAP LAKE

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1. INTRODUCTION

Eurasian water milfoil (Myriophyllum spicatum L.) was first discovered in the Salmon Arm of Shuswap Lake in August 1981 when small weed beds of low density were documented at Sicamous Beach, Captain's Cove Marina and Syphon Creek (Figure 1). In October of that year an emergency intensive control program was undertaken by the Water Management Branch (W.M.B.) to prevent further spread of this potential nuisance weed. Based on the favorable results of the initial program and the potential adverse impact of extensive weed growth on the tourist-based economy of the area, the Regional District of Columbia-Shuswap (R.D.C.S.) requested an annual continuation of control activities.

Subsequent M. spicatum control programs were conducted under a 75-25 cost-sharing agreement between the province and the R.D.C.S. The objectives of these programs were: (1) to prevent the development of nuisance M. spicatum populations, (2) to prevent further spread to non-infested areas in the region, (3) to gain experience on the overall effectiveness of control technologies in Shuswap Lake, and (4) to document the abundance and distribution of M. spicatum in Shuswap Lake. The 1982 intensive control program was generally successful in preventing increases in abundance and distribution (Einarson and Foord, 1983). The 1983 program was less successful since the infested area doubled from 6.27 to 15.0 ha during the growing season, despite control efforts underway at that time (Einarson, 1984). M. spicatum populations were then widespread throughout Salmon Arm, although at very low densities.

In 1984 a third cost-sharing agreement was signed with R.D.C.S. This program adopted a semi-intensive approach. The objectives differed from previous programs in that attempts were aimed at controlling weed growth at moderate to high use sites (thus preventing the development of local nuisance operations) but discontinued control measures in low use areas. The 1984 program activities, and relative time allocations are shown in Table 1. The program consisted of a thorough survey of previously infested

areas in Salmon Arm, and selected sites in the non-infested areas of Shuswap Lake as well as Little Shuswap, Mara and Mabel Lakes. Control measures used included diver dredging, handpicking, bottom barrier applications and derooting. These control methods followed recommendations of the 1983 report with a contingency plan calling for activation of the diver dredge to deal with unexpected population increases.

During the previous three programs the province had an active role in all phases of the project including: planning, consulting, recommmending treatment options and contributing services to surveillance and control activities. In 1984 a more effective use of the available skills and expertise was made by dividing duties between W.M.B. and R.D.C.S. staff members. The provincial service contribution was surveillance, monitoring and technical assistance when required. Virtually all of the control activities were carried out by R.D.C.S. field staff or through contracts under R.D.C.S. supervision.

2. CONTROL MEASURES

Control measures implemented under the semi-intensive approach in 1984 treated only a portion of the M. spicatum growth documented in Salmon Arm. Table 2 lists a summary of sites treated, dates, treatment methods and areas covered. Treatments consisted of a combination of diver dredging, hand picking, bottom barrier and derooting technologies. Sites treated are shown in Figures 2, 3 and 4; the total area treated in 1984 was 19.86 ha. This gross area total includes repeated and overlapping treatment technologies of approximately 4.5 ha. The net area treated was 15.36 ha. Control activities required a total of 50 calendar days. A comparison of treatment methods utilized, time spent and area covered is provided in Table 3.

A field supervisor was hired by R.D.C.S. from July 23 to September 26, 1984 to supervise most control activities in Shuswap Lake. The supervisor hired three field assistants to implement control treatments between July 30 and September 21, 1984. Winter derooting treatments were conducted between October 6 and December 5, 1984. These treatments were implemented by W.M.B. staff with the rotavation derooting treatments contracted to experienced staff of the Okanagan Basin Water Board. The timing of derooting operations and the availability of qualified operators for this specialized equipment necessitated this action.

2.1 DIVER DREDGING

Diver dredging operations began at Sandy Point on August 7, 1984. As lake levels dropped (Figure 5) and water clarity increased it became apparent that weedbed size and density exceeded the effective normal operating constraints of this technique. Diver dredging for root removal was therefore discontinued and instead used to remove surfacing vegetation. This effort was made to prevent the spread of fragments generated by boat traffic to other areas of the lake. After removal of most of the surfacing weed growth, dredging operations were suspended in favour of winter derooting using the tillage equipment.

Other areas treated by diver dredging included Sandy Point (site 21), Sicamous (sites 1, 2 and 5) and Syphon Creek (site 23) (see Figures 2, 3 and 9). In these areas the dredge was used to treat small, low density populations well within the root removal operational constraints of this technique.

A total of 4.33 ha were treated using the diver dredge; approximately 1.25 ha occurred at Sandy Point. Dredging was time consuming, requiring 22.5 days of operation. One half of this time was spent removing surfacing weed growth at Sandy Point. Preliminary effectiveness observation indicated good root removal rates, especially in the Sicamous area. Further monitoring in 1985 will be required to assess overall treatment effectiveness.

2.2 HANDPICKING

Handpicking continued to be a useful control technology. Based on our experience in previous seasons, handpicking was used only in areas of low population density (less than 20 percent) and small size (less than 1.0 ha). Most of the growth sites east of Engineers Point matched these treatment specifications; however, because of the semi-intensive approach of the program not all sites qualified for treatment. Five sites were exclusively handpicked, while another four were handpicked to supplement or follow up other control measures. The total area handpicked in 1984 was 7.6 ha; this includes the supplementary treatments (i.e.: Eagle River) and multiple treatments (i.e.: Captain's Cove). A total of 14.0 days was spent at these treatments, roughly one-half of the dredging total. The differences in time spent per unit area are mainly due to the higher weedbed densities of the dredging sites, and therefore lower production rates.

2.3 BOTTOM BARRIERS

Little bottom barrier material was used in 1984. The difficulties associated with implementing alternative treatment technologies around the bottom barrier installed at Sandy Point in 1983 led to a re-evaluation of the situations considered appropriate for use of this technique. This year

only small, high density populations, in areas unsuited for other treatments (in particular derooting) were considered. The Sunnybrae Bible Camp (site 30) was the only site determined suitable for bottom barrier installation in 1984. Approximately 0.03 ha of burlap was installed in one day at this site. The effectiveness and site suitability of this treatment will be re-assessed in 1985.

2.4 DEROOTING

Derooting techniques were used to treat the large, high density populations at Sandy Point (sites 22a and 22b, Figure 9); the area treated this year was similar to that proposed, but not completed, in 1983. Portions of this site were treated earlier in the year by diver dredging and handpicking. The inability to work effectively around the bottom barrier installed in 1983 combined with the incomplete derooting of this zone due to adverse weather conditions in December 1983, appear to be major factors leading to ineffectiveness of the 1983 derooting treatments. The amount and distribution of M. spicatum remaining after 1983 derooting treatments is illustrated in Figure 6.

In 1984, winter derooting treatments were conducted between October 16 and December 5, to avoid possible adverse weather conditions. Remnants of the 1983 bottom barrier were also removed to allow complete treatment of this zone. The land-based Bombardier Muskeg tractor with cultivator was used to treat the area from water level to the 1.0 meter depth contour (+0.5 meter datum). The treatment zone is shown in Figure 7. The exposed foreshore above water level was not treated. Due to an accident involving the Muskeg tractor, the preferred treatment strategy of double coverage (passes parallel and perpendicular to the shoreline) could not be followed this year. In this case only single coverage was completed. Over the 3.5 days of operation prior to the accident, approximately 3.0 ha was treated. A portion of the shallow zone initially left untreated was treated later, where water depth allowed, using the deep water derooting equipment.

The floating rotavator was used to treat the deeper foreshore zone at Sandy Point between 0.5 and 3.5 meter water depths (+0.5 and -2.5 meter datum respectively). Unfortunately, the lower lake level did not allow complete re-treatment of the portion of this site which was not effectively treated by the cultivator. The area between 0.50 and 0.25 meter datum was retreated; this is approximately one half of the shallow zone. The total area treated by the rotavator was 6.5 ha; 1.5 ha of the 3.0 ha shallow tillage zone and 5.0 ha - all of the deep zone. Nine days were required for the rotavation treatments. This allowed for multiple passes of the equipment over the most densely infested areas at this site.

Preliminary observation of the Sandy Point derooting area revealed little visible M. spicatum material. Quantitative measurements of population density, measured prior to the 1984 derooting treatments, will be compared to similar measurements in 1985 to determine treatment effectiveness.

2.5 EFFECTIVENESS

The net area treated in 1984 was 15.36 ha. This area corresponded to treatment of 12 separate growth sites, roughly one half the number of sites documented during 1984 surveys. At this time it is difficult to assign effectiveness figures to the 1984 control treatments. However, preliminary post-treatment observations may allow predictions of treatment effectiveness based on current observations, and previous effectiveness information. Slight reductions in population size and density may be expected at most handpicking sites. Root removal by diver dredge at Sicamous and Syphon Creek also appeared effective. Removal of standing weed growth at Sandy Point also was successful in that the treatment reduced fragment generation and spread. The area was later retreated using derooting equipment to remove remnant root material. Initial post-treatment observations of the derooting site also indicated a relatively successful treatment.

On the whole, control measures implemented in 1984 appeared successful where control was attempted. However, since less than one half of the

affected area was treated in 1984, the overall program effectiveness is doubtful. The negative affects of leaving more than one half of the Shuswap Lake infestation untreated will overshadow the effectiveness of localized control measures.

3. DOCUMENTATION OF ABUNDANCE AND DISTRIBUTION

3.1 SURVEYS AND MONITORING

Surveillance was conducted by W.M.B. as part of the provincial service contribution to the Shuswap Lake Eurasian water milfoil control program. Several surveys were completed during the year to:

1) Observe M. spicatum populations to determine when new seasonal growth is initiated.
2) Evaluate effectiveness of 1983 control treatments.
3) Document abundance and distribution, prior to 1984 control measures, to guide 1984 control treatments.
4) Monitor 1984 control treatments.
5) Assess abundance and distribution of M. spicatum in the Shuswap Lake system following 1984 control efforts.

Preliminary weed growth surveys were conducted in mid April during low water and were followed by an update survey in early July at maximum water levels. The April survey conducted at Sandy Point and Syphon Creek found only remnant 1983 M. spicatum growth; all macrophytes were senescent with heavy epiphytic covering. Without visible new growth, the viability of stem and root material uprooted or buried by 1983 derooting efforts could not be determined. Plant samples were collected from above the drawdown area. The viability of this material was confirmed by lab rearing conducted by W.M.B. staff in Vernon.

The absence of actively growing plants limited the value of the early survey, indicating only the location of untreated remnant plant material. New stem growth was not observed at these sites until the July 4 survey when SCUBA observations noted robust stem growth (from well developed root crowns) reaching three meters in height. High lake levels (4.34 meter datum) and poor visibility because of turbid water made large scale assessment observations impossible at this time.

Pre-treatment surveys to observe weed growth and guide control efforts were conducted between July 23 and August 14, 1984. Continuing poor survey conditions necessitated SCUBA searches to check many of the 1983 growth sites. Locations of M. spicatum populations observed are shown in Figure 8. Site specific details of population size, density and vegetative conditions are listed in Table 4. Weedbeds of small size and low density were observed at most 1983 growth sites. The areas of heaviest growth were noted at Sandy Point, Syphon Creek, Tappen Bay and Sunnybrae. The infested area was estimated at 9.39 ha, or 5.61 ha less than that documented in 1983. The pre-treatment estimation of infested area is subject to error due to the inability to observe all weed growth under poor survey conditions - even in areas of known infestation and especially any new locations of infestation. A total of 6.17 ha of weed growth was documented within 1983 treatment sites, 8.1 ha (or 56 percent) less than the infestation noted in 1983. A further 3.22 ha was noted in sites left untreated in 1983, nearly four times more than the area left untreated last year. Sites handpicked in 1983 (at Sicamous and along the Canoe foreshore) were small and of low vegetative density. Bottom barrier and derooting treatments at Sandy Point in 1983 were not effective, as indicated by the large quantity of remnant plant material. Most of the 6.17 ha of affected area remaining within 1983 treatment sites was located at Sandy Point.

3.2 STATUS OF EURASIAN WATER MILFOIL GROWTH IN 1984

A survey of Shuswap (except Anstey Arm), Mara, Mabel and Little Shuswap Lakes was conducted by W.M.B. between October 1 and October 25, 1984 to document the extent of M. spicatum infestation in the Shuswap Lake system. Low lake levels and high water clarity allowed traditional boat surveying techniques to be used. Due to the lengthy shoreline in the Shuswap system, surveillance was performed only in selected sites. Although the entire shoreline of Salmon Arm was surveyed, observations in the non-infested lakes were priorized by proximity to:

1) known M. spicatum growth,
2) marinas and high use areas, and
3) naturally weedy areas such as shallow embayments, dredged lagoons, developed foreshore areas and stream outflows.

No M. spicatum growth was found outside the Salmon Arm of Shuswap lake. Large weedbeds of native plants were noted in all lakes, several of which cause, or may cause, nuisance conditions. Areas of particular concern were noted at: Crystal Sands and Sicamous foreshore in Mara Lake; Mabel Lake Provincial Park, in Mabel Lake; Wild Rose Bay, Blind Bay and Scotch Creek, in the non-infested areas of Shuswap Lake; and the eastern end of Little Shuswap Lake. Sites such as Crystal Sands and Captain's Village at Scotch Creek typify these concerns. At these sites, dense, surfacing Myriophyllum exalbescens (Fern.) populations have been documented, reinforcing the theory that spread of M. spicatum to these sites is possible and that M. spicatum could develop to nuisance proportions once it arrived.

The discovery of M. spicatum in Cinnemousun Narrows suggested that weed growth may have spread to sites outside the Salmon Arm. However, to date no sitings of M. spicatum growth have been reported or observed outside Salmon Arm.

3.3 POPULATION TRENDS

Surveys conducted in Salmon Arm in 1984 documented 33 sites of M. spicatum growth, 17 more than noted in 1983. Weedbed locations and site specific information are illustrated in Figure 9 and listed in Table 5. The site number increase includes five small weedbeds in the Sicamous area, two of which were noted but effectively eradicated during the 1981 control program (Maxnuk and Einarson, 1982; Einarson, 1983). The remaining 12 new sites were in the western end of the Arm, near the municipality of Salmon Arm. The total area infested by M. spicatum in October, 1984 was 28.02 ha; of this 5.07 ha (18 percent) occurs east of Canoe with the remaining 22.95 ha (82 percent) west of Canoe. The infested area is virtually double that recorded in 1983, and three times that documented in July 1984.

M. spicatum growth in Shuswap Lake is increasing in number of sites, population sizes and in some cases density, although overall distribution remains similar. Area affected has doubled in each of the last two years; most of the increase has been observed in the western end of Salmon Arm (Figure 9). This section of Salmon Arm has the most growth sites, largest affected area, and most robust weed growth, as indicated by comparison of population data collected in July and later in October, 1984. Several explanations are apparent; control measures implemented in the western portions of Salmon Arm (i.e. Sandy Point) have not been particularly effective, and only selected sites have been treated, thereby leaving sufficient plant material to recolonize the treated sites and expand to new sites. M. spicatum growth east of Canoe is generally of small size with fewer stems per root crown and low population density. However, the appearance of the small isolated populations in Sicamous Narrows (towards Mara Lake) and Old Town Bay indicates the trend towards expansion in the eastern parts of Salmon Arm.

Expansion of M. spicatum populations in Salmon Arm will continue. The growth and development of mature populations as seen in Mud Bay (in spite of high turbidity levels) and in the Syphon Creek-Sandy Point area (subject to exposure during winter drawdown) confirm the adverse conditions under which M. spicatum can grow. Gradual expansion to other naturally weedy areas throughout the Shuswap systems also may be expected, as occurred in the Okanagan Valley lakes. However, the rate of expansion within Salmon Arm and spread to downstream areas and into adjoining water bodies could be slowed through implementation of more intensive control programs.

4. PREVENTION AND PUBLIC INFORMATION

A public information campaign similar to that implemented during the 1983 program was conducted prior to commencement of the 1984 program. Public information services were conducted by W.M.B. and not included as part of the cost-shared portion of the project. A concerted effort was made to inform the public, especially local governments and service organizations, about the Shuswap Lake control program. W.M.B. provided pamphlets, posters and other literature illustrating the ecology and control of M. spicatum to the Salmon Arm Chamber of Commerce for distribution to tourist information centers and local businesses. Local, public meetings were attended by W.M.B. staff to present more detailed information and answer questions concerning growth dynamics, ecology, and available control technologies. Information billboards erected in 1983 on the Trans Canada Highway were maintained in 1984 to encourage public awareness, as were prevention signs posted around the lake at boat launching and marina facilities. Weekly press releases were provided to the media through R.D.C.S., describing current surveillance information and control activities. A major form of public information distribution continued to be through the direct contact between program employees and concerned citizens met during the course of program activities.

Although small components of the Shuswap Lake control effort, prevention and public information activities are important. Provided with a basic knowledge of M. spicatum ecology, status of the infestation and the costs or benefits of control options, the public and local officials can better appreciate and contribute to the overall program.

5. PROGRAM COSTS

Funding was provided to the Shuswap Lake Control Program through a 75-25 cost-sharing agreement between the Province and R.D.C.S. The total cost of the 1984 Eurasian water milfoil program was $37 919.88, the cost-shared portion of which was $34 730.00. The 1984 program was initially budgeted at $29 300.00 This included a provincial cash contribution of $14 400.00 and services valued at $7 500.00; R.D.C.S. contributed $7 326.00 in cash as well as office space, storage facilities, and administrative support. The budget was later increased by $5 430.00 ($4 072.50 from the province and $1 357.50 from R.D.C.S.) at the request of R.D.C.S. to cover shortfalls in the original funding.

A summary of 1984 program costs is listed in Table 6. Control costs of $29 900.74 were the largest portion of program expenditures. Labour costs associated with control activities (salaries, contract costs and provincial service contribution) were $22 616.33. Operating expenses totalled $4 676.52 and vehicle leases (a non-cost-shared item) cost an additional $2 608.08. A comparison of past and present programs is shown in Table 7. The 1984 control activity costs were roughly 40 percent greater than 1983 costs and 378 percent higher than 1982. Increased costs are reflected in the greater percentage of time spent at this activity and a lower cost per unit area treated in 1984.

Surveillance and monitoring costs were relatively low in 1984 compared to past programs. Costs of surveillance activities in 1984 were $6 297.26; approximately one third of 1982 costs and 10 percent less than 1983 costs. The lower costs is due to the decreased time allotted to surveying.

The remainder of the program costs were administrative costs assessed to the Regional District ($1 721.88, which included a $587.88 service contribution by R.D.C.S.).

6. MANAGEMENT OPTIONS FOR FUTURE CONTROL

For the past four years M. spicatum surveillance and control activities have been undertaken in Shuswap Lake. All commonly used treatment technologies, with the exception of harvesting and herbicide applications, have been utilized to reduce M. spicatum growth in Shuswap Lake. These first years were an educational phase, which included considerable uncertainty in the program management strategies. The experience gained from this work indicates that there are several management strategies for future control programs. Most importantly, M. spicatum cannot be eradicated in Shuswap Lake. The strategies considered here are the intensive, semi-intensive and cosmetic levels of control.

Intensive Control

The intensive control option would treat all known infestations of M. spicatum, using a combination of the most effective control techniques. The objective of this approach would be to reduce the infested area to the lowest possible size and density. Details of the intensive control option are listed in Appendix I. The treatment options listed match technical consideration and effectiveness to site morphology, substrate type and vegetative conditions. The use of herbicides (2,4-D) has also been considered but is not recommended at this time. The granular and liquid formulations cannot be used in many areas due to the dilution effects of surface and groundwater inflows. Also, conflict with salmonid spawning and juvenile rearing may be expected in some areas. The intensive treatment considered for use in 1985 would deroot 15-20 ha and diver dredge the remaining 12.82 ha. A contingency plan to enable treatment of undocumented or new growth in 1985, of up to ten ha, would also be considered.

The intensive management strategy would be costly and must also be continued annually to be beneficial in the long term. A forecast of expenditures is listed in Appendix I; a program of this size is estimated to cost $145 900.00. Treatment ineffectiveness or an inability to treat all infestations would ensure an ever-increasing area of infestation and a

corresponding increase in program costs in future years. Effective treatments in 1985 and low re-colonization rates may, however, allow control measures to be relaxed in some areas, without seriously affecting the quality of control. This should stabilize, or possibly reduce, program costs in 1986 and future years.

Semi-intensive Control

A semi-intensive control strategy would only treat M. spicatum growth sites of moderate to high nuisance potential, in areas of moderate to high recreational use. The objective of this approach would be to reduce weedbed densities to non-nuisance levels in these areas; however, not all growth sites would be treated. Treatment methods used would emphasize cost-effective technologies. In some cases dredging or handpicking would be used; these are the most cost-effective methods in weedbeds of small size and low densities. In three large weed beds with high densities, derooting methods would be used. Weedbeds in low use areas (such as Tappen Bay) would remain untreated.

The 1984 program followed the semi-intensive approach. A similar program, if followed in 1985, would call for the use of treatment options shown in Appendix I, part 3. Derooting treatment would be implemented in 9.75 ha of the larger weedbeds, in higher use areas. Diver dredging and handpicking would be used, where applicable, in a further 6.94 ha. The cost of a program of this nature would be $51 000.00.

Continued control at the 1984 level would minimize the impact of nuisance M. spicatum growth in high use areas; however, given the spread of M. spicatum during implementation of the 1984 program, the development of nuisance populations in adjoining untreated areas would occur rapidly. This expansion would mean losing the option of intensive control and ultimately result in the implementation of a large cosmetic program or a very costly semi-intensive program.

Cosmetic Control

The third option considered is the cosmetic management strategy. With this approach, cosmetic measures would be implemented at areas of high public use or where weed growth impeded or interfered with normal water use. The object of the cosmetic approach would be to manage the nuisance impact of populations by the cheapest means without regard for the spread to other sites or lakes within the Shuswap system.

Cost-effective, high production harvesting and derooting methods would be used. Small scale bottom barrier applications would also be considered for use in specific areas. Harvesting removes top growth which would effectively control deep water surfacing populations although for only a short time. Derooting techniques used in beach areas would provide a more acceptable level of management for these nuisance populations. Bottom barriers, used in small site specific applications, would provide a longer term cosmetic management.

The simple cost of cosmetically controlling these populations would be low with harvesting costs at roughly $600 per hectare and derooting at $800 per hectare. However, additional equipment might be required and longer term costs of operating and maintaining this specialized equipment would increase the unit area cost. As the infested area increased and harvesting areas increased with time the unit area cost would become lower, but total costs would become greater.

At present only a few sites support nuisance aquatic plant populations in Shuswap Lake. The high costs associated with treating these small areas would probably mean suspending the program for 1985 until such time that sufficiently large populations requiring harvesting and/or derooting had developed (expected in 1986). Continued growth, and expansion of the infestation to adjoining lakeshore and connected lake systems, would rapidly occur in absence of any controls in these low use areas. As a result, a larger, more costly cosmetic control program would be required sooner than if intensive or semi-intensive management strategies were initially followed.

7. CONCLUSIONS

The objectives of the 1984 Shuswap Lake Control Program were to: 1) prevent development of nuisance M. spicatum populations, 2) prevent further spread, 3) gain experience on effectiveness of control technologies, and 4) document distribution of M. spicatum.

Monitoring surveys were conducted during the spring and early summer of 1984 to assess effectiveness of 1983 control treatments. The early surveys, conducted during low water, did not allow determination of 1983 treatment effectiveness, but located areas of remnant plant growth and were used to plan later surveillance and control activities. Robust new plant growth was first noted in early July during freshet. High lake levels and turbid water conditions did not appear to affect M. spicatum growth adversely. Surveys later in July located 9.39 ha of M. spicatum growth; approximately 3.22 ha was in untreated areas and 6.17 ha was remnant growth within 1983 treated sites. Approximately 3.5 ha of the 6.17 ha was located at Sandy Point. Site expansion was also observed in the untreated sites. Handpicking treatments in the small, low density weedbeds of Sicamous and Canoe appeared effective, showing a 73% reduction in infested area. The treatments in the larger weedbeds of Sandy Point were less effective, showing a 56% reduction in infested area.

Control measures implemented in 1984 followed the recommendations for a semi-intensive control strategy as outlined in the 1983 Shuswap report. Under this management strategy, only 12 sites of M. spicatum growth were treated; net area treated was 15.36 ha. Control measures in 1984 covered 5.6 ha more than similar treatments done in 1983. Although the 1984 program treated the largest area, with the greatest cost, control measures treated only 55% of the total infested area. In comparison, treatments in 1983 covered roughly 85% of the infested area.

Post-treatment monitoring in October 1984 indicated good removal rates for handpicking and diver dredge treatments in the Sicamous area as well as

for diver dredging at Syphon Creek. Remnant plant material was located, although no regrowth had occurred. This did not permit an assessment of treatment effectiveness. Winter derooting conducted during late October and November 1984, occurred after the fall survey and therefore was not monitored.

The post-treatment surveys of the Shuswap system were conducted to assess the distribution and abundance of M. spicatum. As yet M. spicatum has not spread outside Salmon Arm. A total affected area of 28.02 ha was documented at 33 separate sites in Salmon Arm. New growth was noted at 17 sites, 10 sites showed no change, four showed increases and two showed decreases in population size and density. Overall, the Shuswap Lake infestation continues to be of low density although widespread in distribution.

A doubling of infested area has occurred in Salmon Arm in spite of the control measures implemented. This is a direct result of ineffective or incomplete control treatments. Those areas remaining will grow and expand at a high rate. The growth dynamics of M. spicatum during a single growing season are demonstrated through comparison of the pre-treatment and post-treatment surveys. The largest increases occurred at Sandy Point, Mud Bay and Sunnybrae. Site expansion at Sandy Point, due to regrowth and re-colonization, increased the site size from 3.5 to 8.5 ha. Since only a portion (55%) of the infested area was treated in 1984, further increases in infested areas can be expected in 1985, regardless of treatment effectiveness. For this reason, the three options for future control programs should be carefully considered.

A cosmetic management approach would result in little long term benefit. This option would treat only the nuisance growths in high use areas. At present, few sites have developed to nuisance levels, therefore, no control measures need be implemented until sufficient plant growth develops.

The initial cost would be low; however, capital equipment costs and need for treatment of larger areas the following year would absorb any immediate savings.

The semi-intensive strategy used during the last few years served to reduce the rate of M. spicatum population increases. However, judging from the 1984 experience these reductions may be minimal. Treating moderate to high nuisance populations would leave numerous small populations, allowing increased growth and site expansions. The cost of implementing another semi-intensive program in 1985 would be approximately $51 000. Judging from the present rate of expansion, a semi-intensive program would rapidly develop into a large cosmetic control program.

An intensive management program in 1985 would apply several different control methods in concert to control M. spicatum growth. The program would attempt to remove as much M. spicatum growth from the lake as possible with present methods and reasonable funding - a process which still would be relatively costly. Continued annual treatments, that achieve a high degree of effectiveness, may allow temporary relaxation of control efforts in some locations. Treatment of all M. spicatum growth should reduce the potential for spread and occurrence of nuisance populations; however, eradication of M. spicatum is not possible. Control for more than one growing season has rarely been observed and at least semi-intensive maintenance is usually required annually to keep populations in check following an intensive program.

The status of M. spicatum in Shuswap Lake is at a critical point. With approximately 77 ha of littoral area available for growth in Shuswap Lake, 138 ha in Little Shuswap and 14 ha in Mara Lake, continued expansion could create a severe negative impact on water-based recreational activities. Fishery resources might also be affected. Continued control of M. spicatum in Shuswap Lake should preserve options available for future programs by extending the time until large cosmetic programs may be required, and delaying spread to available littoral areas of adjacent lakes and the interconnected river system.

8. SUMMARY

1. A third 75-25 cost-sharing agreement was signed by R.D.C.S. and the Province for 1984.

2. The 1984 Eurasian water milfoil control program followed a semi-intensive approach, similar to the 1983 program, which provided control treatments in areas of moderate to high nuisance potential, in high use areas.

3. Twelve sites were treated in 1984 totalling 19.86 ha: diver dredging (4.33 ha), handpicking (7.6 ha), bottom barriers (0.03 ha) and derooting (8.0 ha).

4. The 1984 program treated 5.6 ha more infested area than in 1983, but control measures in 1984 treated only 55 percent of the total infested area.

5. Attempts to evaluate 1983 treatment effectiveness in April, 1984 were unsuccessful. Robust, new M. spicatum growth was not documented until July 4, 1984 at the peak of high, turbid waters of freshet.

6. A total of 28.02 ha of affected area was documented at 33 sites in Salmon Arm during the October 1984 surveys; the infested area doubled since 1983.

7. The 1984 surveys located 17 new infested areas; of the old infestations, 10 sites showed little or no change, 4 sites had increased area and 2 sites had lower density.

8. Most of the remaining Shuswap Lake infestations were of low density and widespread distribution.

9. The 1984 control program was the most costly to date at $37 919.88. Control measures utilized the largest portion of the funding.

10. Future program options include:

a) Intensive	-	$145 900 (approximate cost)
b) Semi-intensive	-	$ 51 000 (approximate cost)
c) Cosmetic	-	No cost expected in 1985 because of relatively low densities

9. REFERENCES

Einarson, E.D. and R.J. Foord. 1983. The 1982 Eurasian water milfoil surveillance and control program in Shuswap Lake. Ministry of Environment, Vernon, B.C. 30 pp. Unpublished report.

Einarson, E.D. 1984. The 1983 Eurasian water milfoil surveillance and control program in Shuswap Lake. Ministry of Environment, Vernon, B.C. 32 pp. Unpublished report.

Maxnuk, M.D. and E.D. Einarson. 1982. Review of Eurasian water milfoil control activities, Shuswap Lake, 1981. Ministry of Environment, Vernon, B.C. 28 pp. Unpublished report.

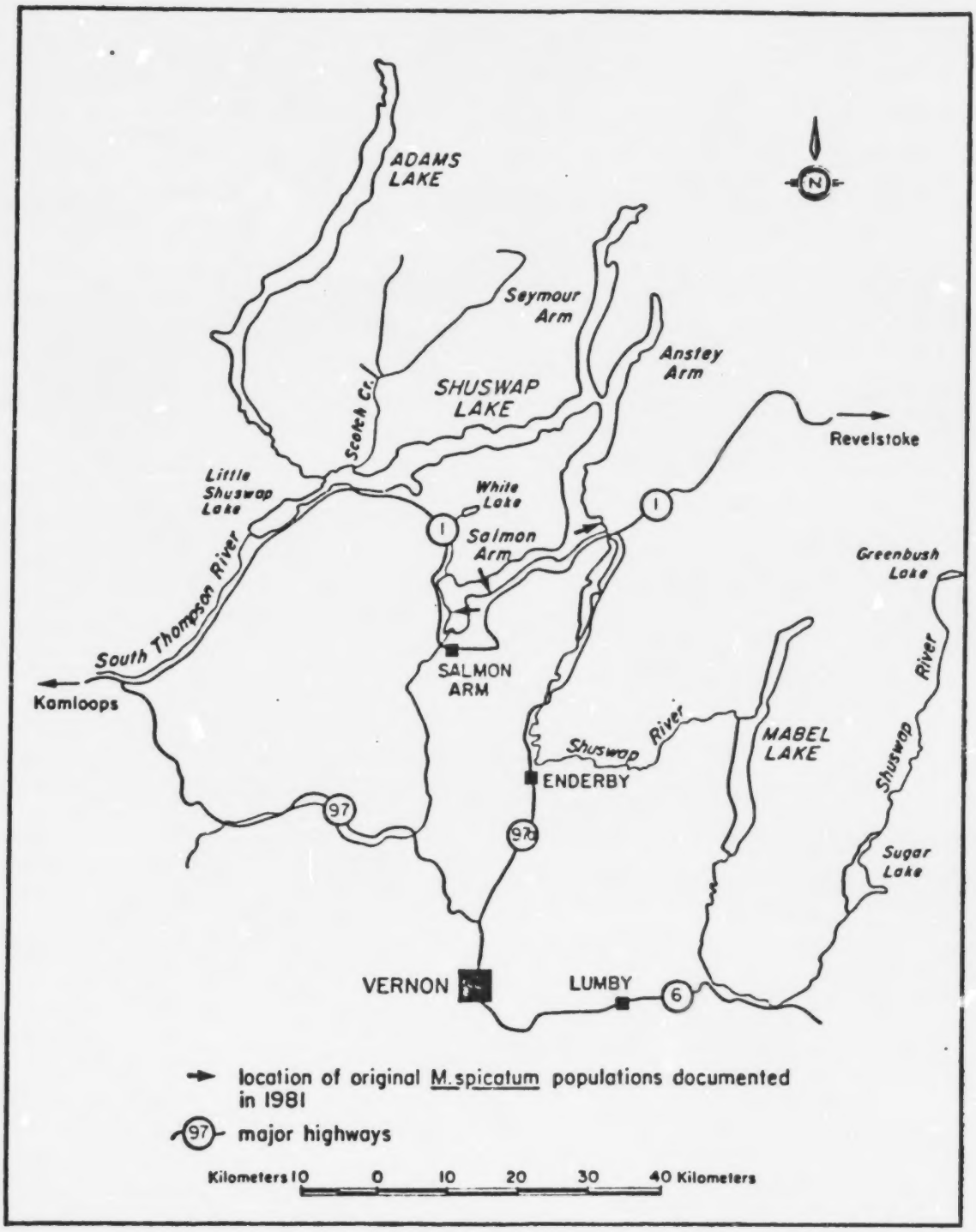

Figure 1 - Shuswap drainage basin in South-Central British Columbia, Canada.

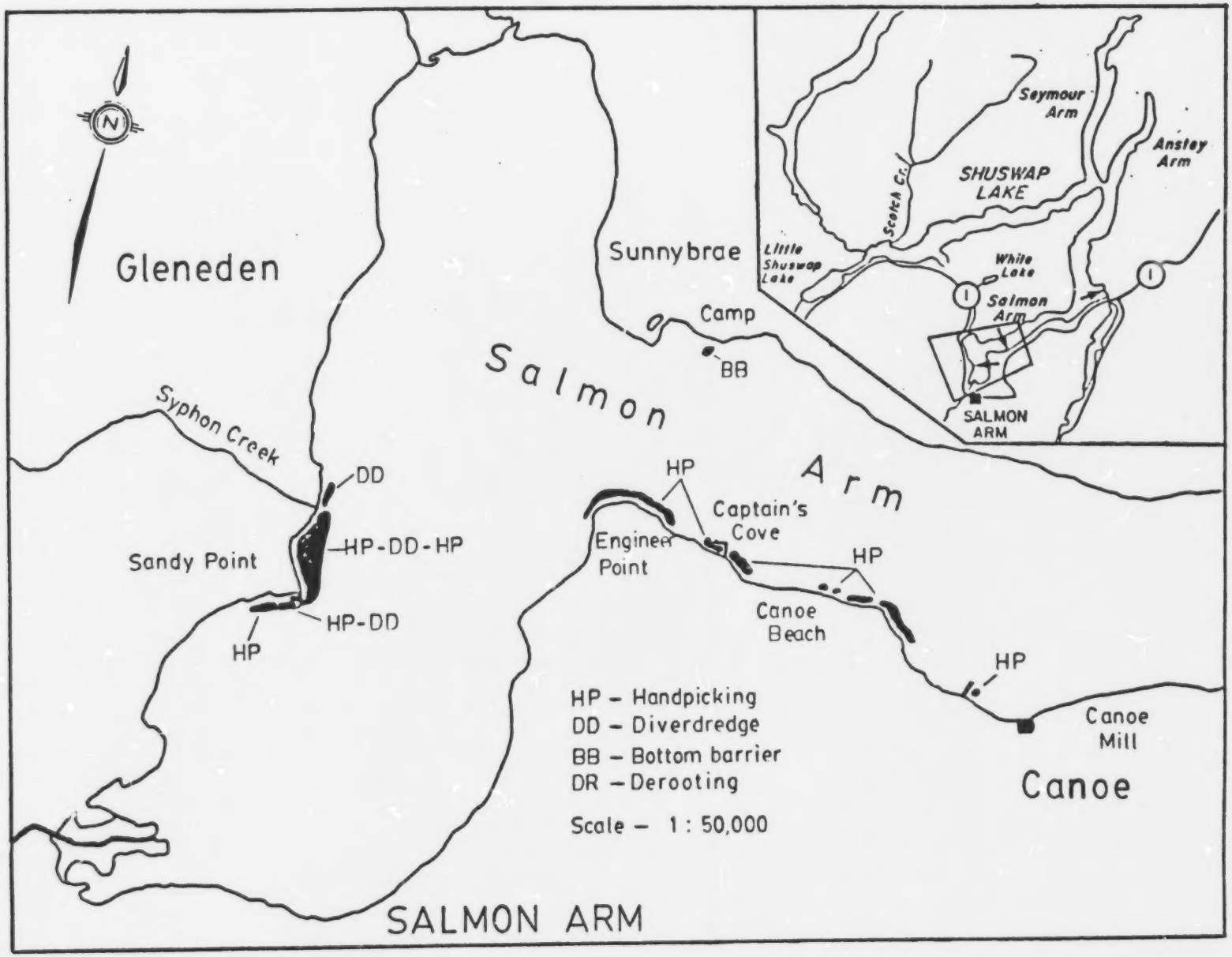

Figure 2 - Salmon Arm (West) detailing M. spicatum control measures utilized and treatment locations - 1984.

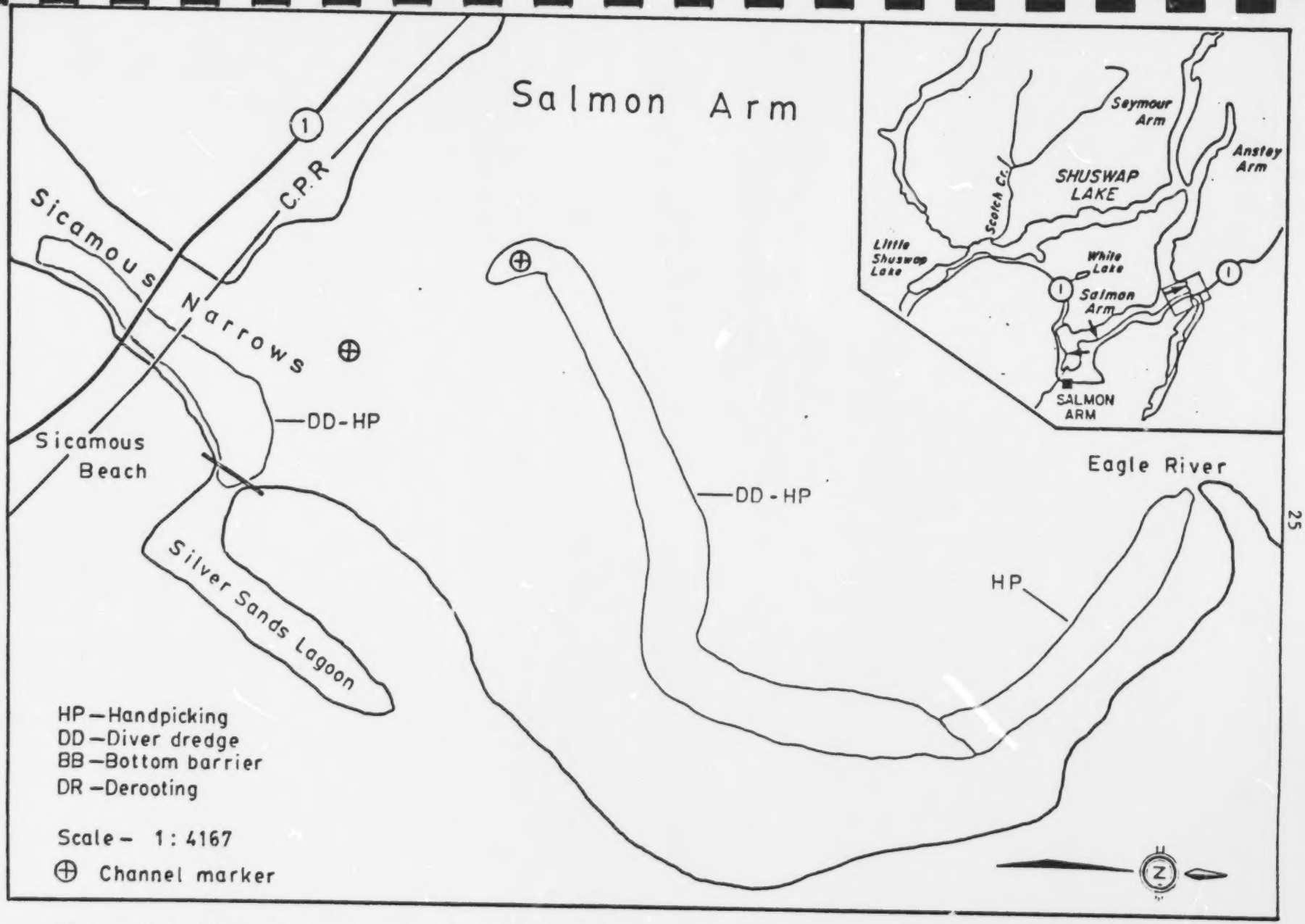

Figure 3 - Sicamous Area, Salmon Arm detailing M. spicatum control measures utilized and areas treated - 1984.

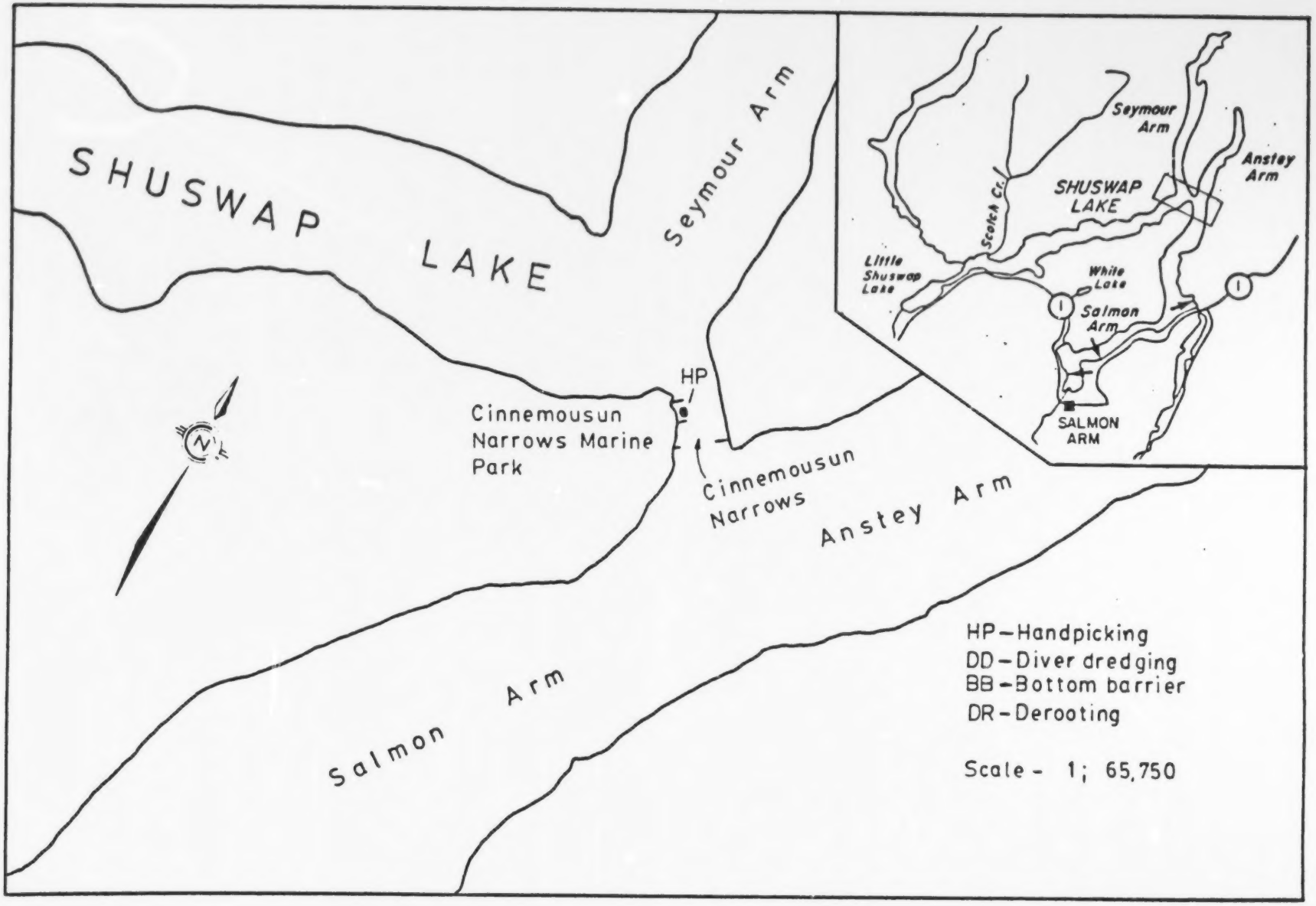

Figure 4 - Cinnemousun Narrows, Shuswap Lake detailing M. spicatum control measures utilized and treatment locations - 1984.

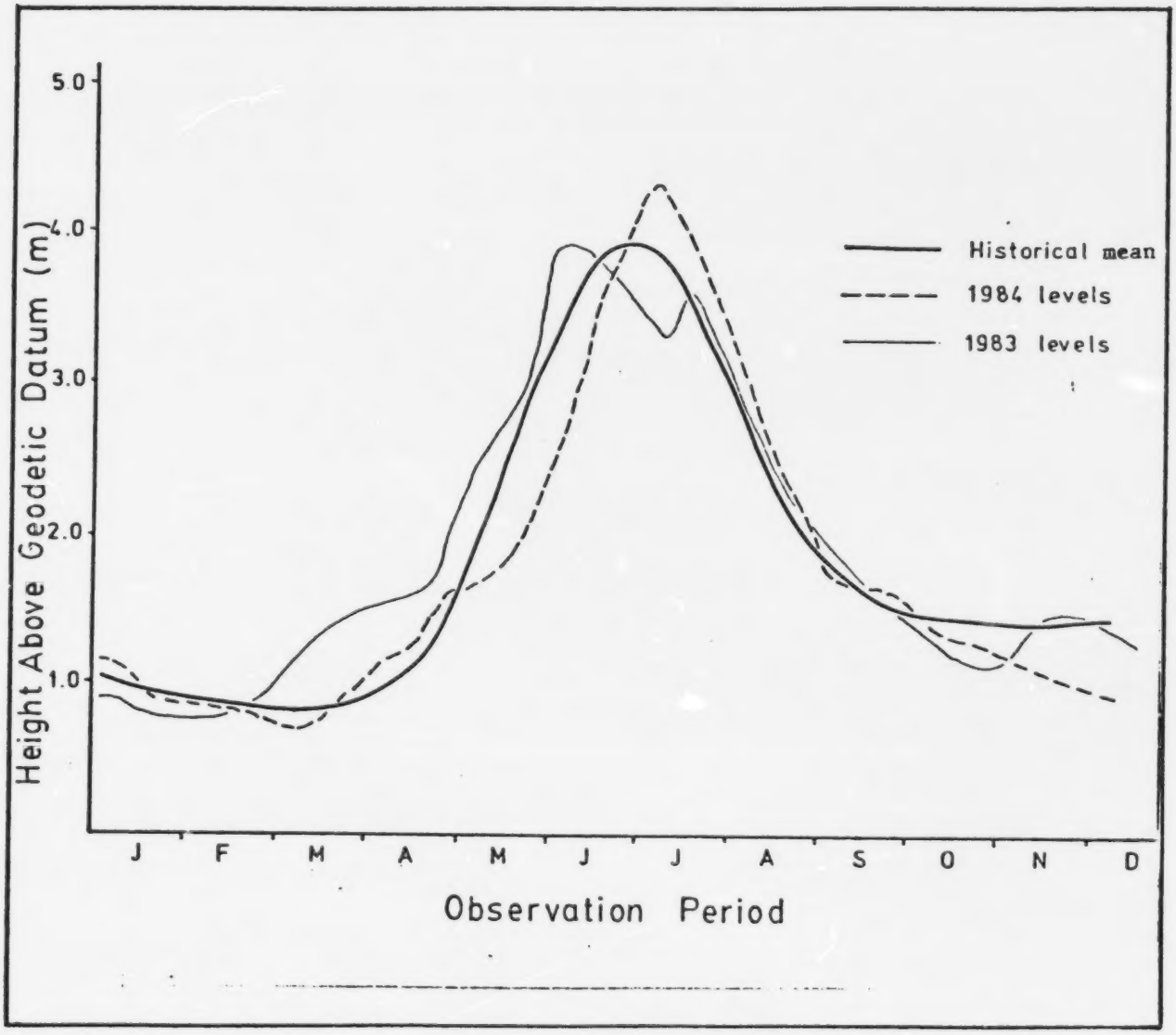

Figure 5 - Historical mean and monthly water levels for Shuswap Lake, at Salmon Arm, 1983 and 1984.

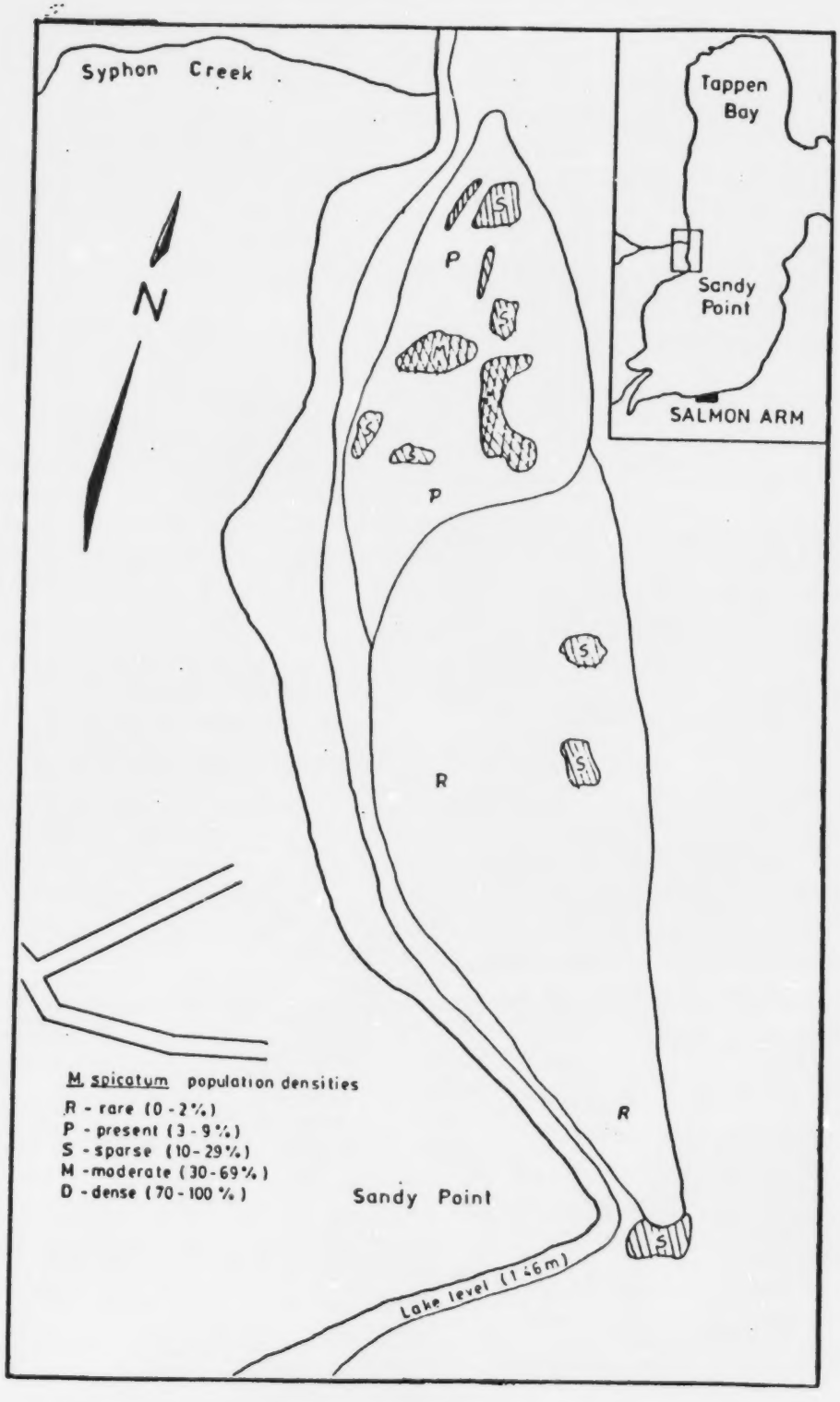

Figure 6 - Post-treatment growth observations of the 1983 Sandy Point Derooting - April 18, 1984.

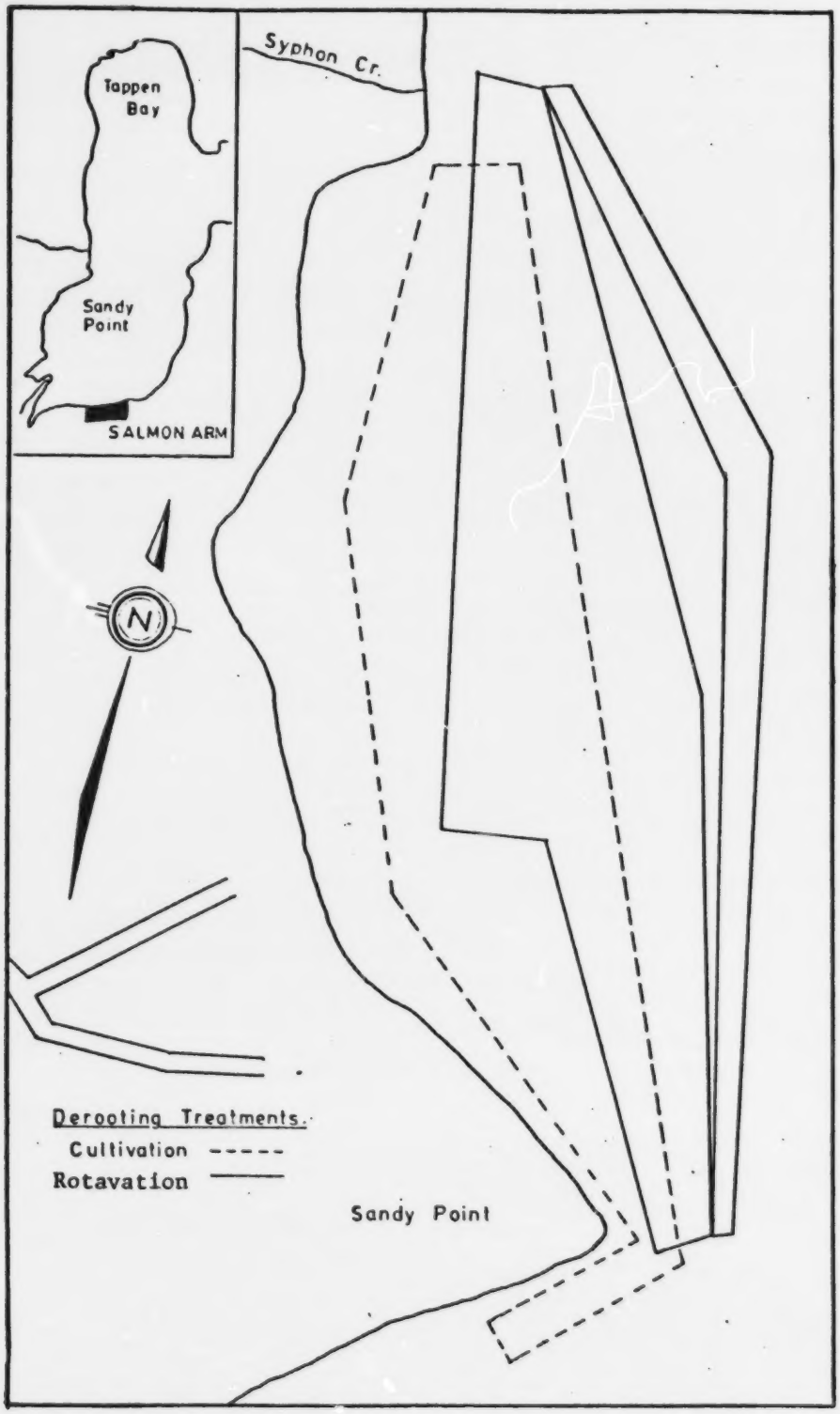

Figure 7 - Sandy Point, Salmon Arm, detailing 1984 Derooting treatments.

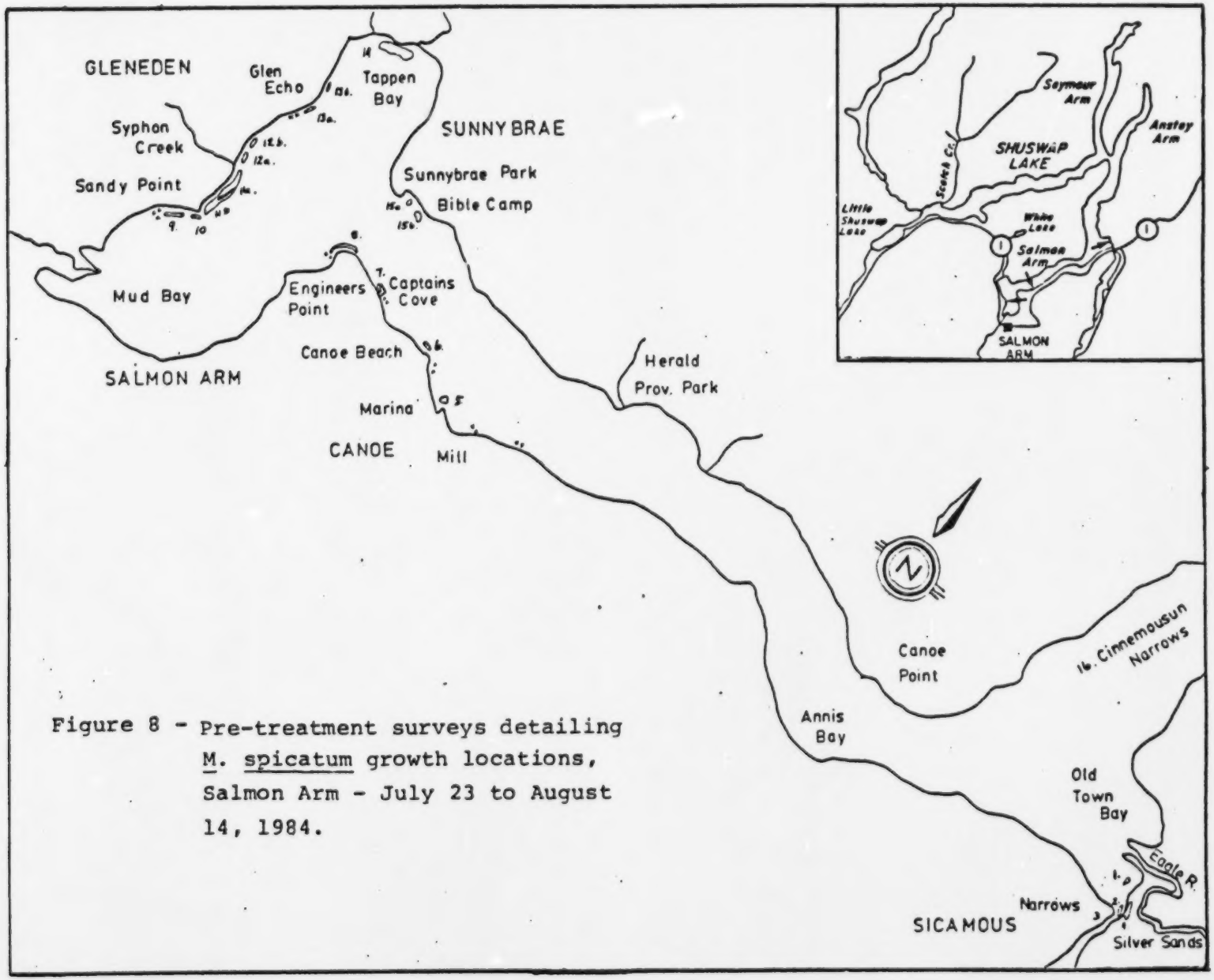

Figure 8 - Pre-treatment surveys detailing M. spicatum growth locations, Salmon Arm - July 23 to August 14, 1984.

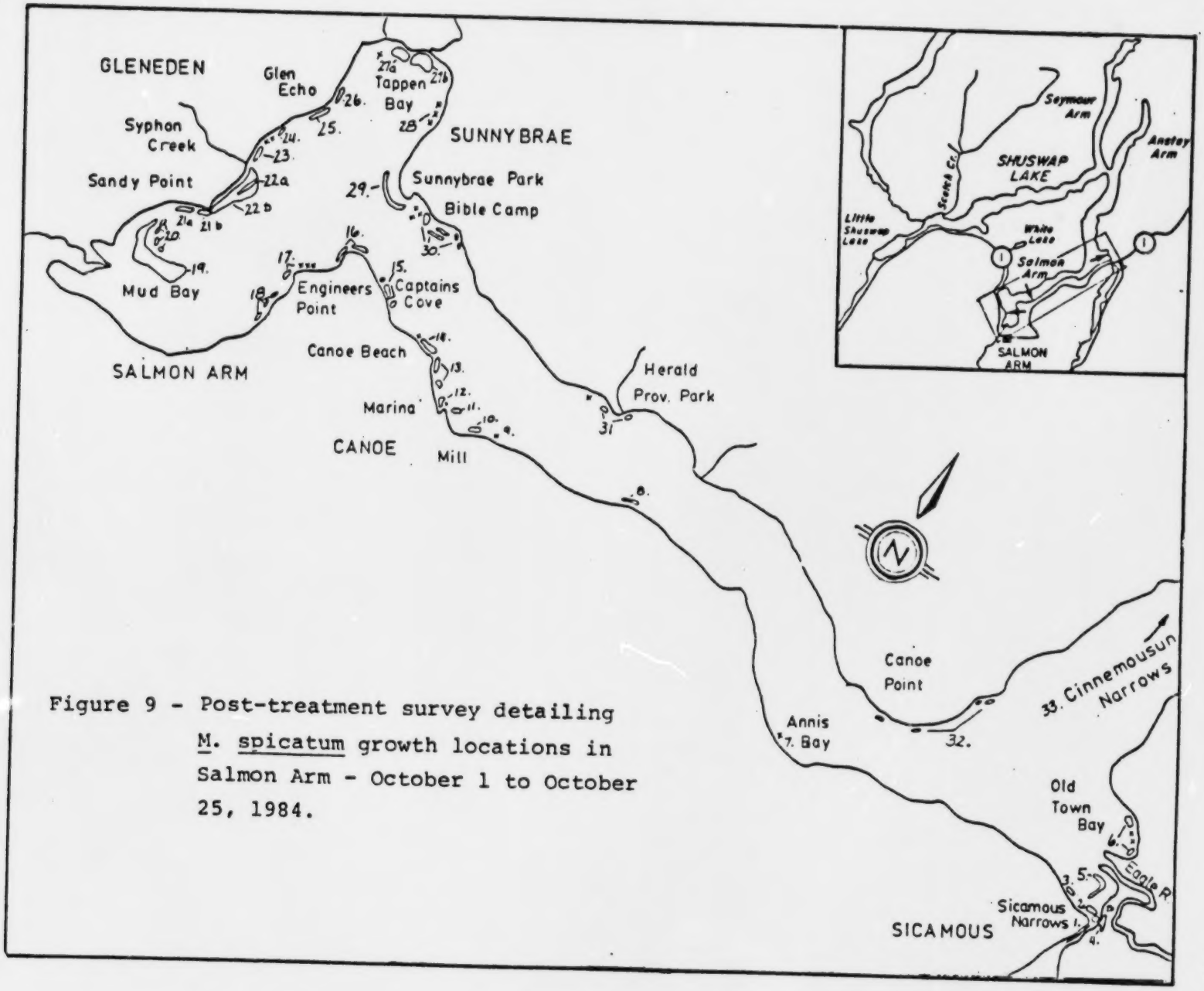

Figure 9 - Post-treatment survey detailing M. spicatum growth locations in Salmon Arm - October 1 to October 25, 1984.

TABLE 1

SUMMARY OF 1984 PROGRAM ACTIVITIES

	ACTIVITY				
	PUBLIC INFORMATION	SURVEILLANCE AND MONITORING	CONTROL TREATMENTS	OTHER	TOTAL
RDCS staff (man-days)	0	0	160	8	168
Provincial staff (man-days)	15	85	13	2	115
Total man-days	15	85	173	10	283
Calendar days	10	39	49.5	10	108.5

TABLE 2

SUMMARY OF CONTROL TREATMENTS UTILIZED IN SHUSWAP LAKE IN 1984

Site Number (1984)	Location*	Date	Treatment Methods	Time (days)	Estimated Area (ha)	Site Comments
1	Sicamous Narrows	Sept. 5	Diver dredging	1.0	0.60	Divers dredged present density weed growth
2	Sicamous Beach	Sept. 6	Diver dredging	0.50	0.20	Divers dredged sparse to moderate density weed growth
		Sept. 6	Handpicking	0.50	0.80	Divers handpicked present density M. spicatum from moderate to dense native weed growth
		Sept. 11	Handpicking	0.25	1.0	Divers handpicked remnant plants after dredging
5	Eagle River	Sept. 7/10	Diver dredging	1.50	0.96	Divers dredge present density along dropoff from the channel markers to the boom pilings
		Sept. 10/11	Handpicking	1.25	1.75	Handpick present density weed growth from the boom pilings to the Eagle River. Divers also re-treated the dredged area to remove remnant plants
13	Canoe Wharf	Aug. 30	Handpicking	0.50	0.75	Handpicking present to sparse weed growth from Canoe wharf to the public swimming area
14	Canoe Beach	Aug. 29/30	Handpicking	1.00	0.40	Handpicking present to sparse weed growth in swimming area amongst moderate density native weeds
15	Captain's Cove	Aug. 24/27	Handpicking	1.50	0.50	Handpicking sparse weed growth within the marina
		Aug. 29	Handpicking	0.50	0.40	Handpicking rare to present weed growth to Canoe Basin
		Sept. 12	Handpicking	0.50	0.40	Re-treated inside of the marina
		Sept. 12/14	Handpicking	1.50	0.50	Handpicking present weed growth to Engineers Point
16	Engineers Point	Aug. 28	Handpicking	1.00	0.50	Handpicking sparse weed growth at Engineers Point
21a	Sandy Beach	Aug. 23	Diver dredging	1.00	0.75	Divers dredged sparse clumps of weeds from within the swimming area
21b	Sandy Beach	July 30/31	Handpicking	2.00	0.19	Handpicking moderate density sub-surfacing plants
		Aug 7	Diver dredging	1.00	0.25	Dredging tall, sub-surfacing plants from near Sandy Pt.
22a	Sandy Point	Aug. 8-13	Diver dredging (cosmetic)	4.00	0.75	Dredging tall dense surfacing plants
22b	Sandy Point	Aug. 1-3	Handpicking	3.00	0.31	Handpicking dense surfacing plants
		Aug. 14-22	Diver dredging (cosmetic)	7.00	0.50	Dredging dense surfacing plants
22 a,b	Sandy Point	Oct. 16 to 19 & 30	Derooting (cultivation)	3.50	1.50	Shallow water derooting of sparse to moderate weed growth
		Nov. 20 to Dec. 5	Derooting (rotavation)	9.00	6.50	Deep water derooting of moderate to dense weed growth
23	Syphon Creek	Sept. 13,14 & 17 to 21	Diver dredging	6.50	0.32	Moderate to dense weed growth was difficult to dredge
30	Sunnybrae Bible Camp	Sept. 4	Bottom barrier (burlap)	1.00	0.03	Installed burlap over moderate to dense weed growth
33	Cinnemousin Narrows	Aug. 16	Handpicking	0.50	N/A	WMB staff handpicking during summer surveys
			Totals	50.0	19.86	

*See locations on Figure 9

TABLE 3

COMPARISON OF CONTROL TREATMENT METHODS USED IN 1984

	Time (days)	Area treated (ha)
Diver dredge	22.5	4.33
Bottom barrier	1.0	0.03
Handpicking	14.0	7.60
Derooting	12.5	8.00
	50.	19.86

TABLE 4

PRETREATMENT SURVEILLANCE AND MONITORING DATA ON M. SPICATUM GROWTH LOCATIONS AND DENSITIES IN SHUSWAP LAKE - JULY 23 TO AUGUST 14, 1984

Location	1983 Site Number*	Estimated Area (ha)	Density	Minimum (Datum) Site Depth	Maximum (Datum) Site Depth	Substrate Type	1983 Treatments
Eagle River	1	1.00	Present	+0.5	0.0	Sand	Handpicked (1.5)
Sicamous Beach	2	0.30	Present	+0.5	0.0	Sand	Handpicked (0.5)
Canoe Mill and Marina	5	0.01	Present	+0.5	0.0	Silt	Handpicked (0.05)
Canoe Beach	6	0.05	Present	+0.6	-1.5	Sand	Handpicked (0.05)
Captain's Cove	7	0.10	Present	+1.0	-1.5	Silt	Handpicked (0.40)
Engineers Point	8	0.10	Present	+1.2	-1.4	Cobble	Handpicked (0.0)
Sandy Beach	9	0.60	Present	+0.6	-3.1	Sand	Handpicked (0.50)
Sandy Point	10	0.20	Moderate	+0.7	-2.3	Sand	Handpicked and Derooted (0.50)
Sandy Point	11a	0.75	Moderate	0.0	-1.0	Sand	Handpicked (0.1) Bottom barrier (0.3) Derooted (3.75)
Sandy Point	11b	3.00	Present	+1.0	-2.5	Sand	Handpicked (1.4) Derooted (4.7)
Syphon Creek	12a	0.05	Moderate	+2.4	+0.5	Silt	Handpicked (0.15) Derooted (0.25)
Syphon Creek/ Pierre's Point	12b	0.45	Rare	+1.5	0.0	Gravel	Untreated
Glen Echo	13	0.05	Rare	+1.6	0.0	Sand	Untreated
Fraser's Beach	No number	0.03	Rare	+0.5	-1.5	Cobble	Untreated
Tappen Bay	14	2.50	Moderate	+1.6	-0.5	Sand	Untreated
Sunnybrae	15a	0.05	Rare	+1.4	0.0	Sand	Handpicked (0.02)
Sunnybrae Bible Camp	15b		Moderate	+1.5	-0.5	Silt	Handpicked (0.08)
		9.39 ha					(Treated 14.27 ha in 1983)

*See locations on Figure 8

TABLE 5

POSTTREATMENT SURVEILLANCE AND MONITORING DATA ON *M. SPICATUM* GROWTH LOCATION AND DENSITIES
OCTOBER 1 to 25, 1984

Site Number	Location*	Estimated Area (ha)	Density	Substrate Type	1983 Site Number	1983 Density
1	Sicamous Narrows	0.50	Present	Clay-Silt	3	Rare
2a	Sicamous Beach	0.05	Moderate	Sand	2	Moderate
2b	Sicamous Beach	0.55	Present	Sand	2	Sparse
3	Hotel	>.01	Sparse	Sand	New	New
4	Silver Sands Lagoon	0.50	Moderate	Sand-Silt	4	Moderate
5a	Eagle River	1.70	Present	Sand	1	Sparse
5b	Eagle River	1.70	Present	Sand	New	New
6	Old Town Bay	0.01	Sparse	Sand	New	New
7	Annis Bay	>.01	Present	Gravel	New	New
8	Railway	>.01	Present	Gravel	New	New
9	Wharf Pilings	>.01	Rare	Sand	New	New
10	East Mill	0.25	Sparse	Organic-Silt	New	New
11	West Mill	0.10	Present	Silt	New	New
12	Canoe Marina	0.10	Sparse	Silt	5	Present
13	Canoe Wharf	0.05	Present	Silt	5	Present
14	Canoe Beach	0.05	Present	Silt-Sand	6	Present
15	Captain's Cove	0.50	Present	Silt	7	Present
16	Engineers Point	0.10	Present	Cobble	8	Sparse
17	Mallard Point	0.05	Moderate	Cobble	New	New
18	Pump House	0.50	Sparse	Cobble-Silt	New	New
19	Mud Bay	4.00	Present	Clay-Silt	New	New
20	Salmon River	1.00	Moderate	Clay-Silt	New	New
21a	Sandy Beach	0.75	Present	Sand	9	Present
21b	Sandy Beach	0.25	Sparse	Sand	10	Sparse
22a	Sandy Point	4.50	Moderate	Sand	11	Sparse
22b	Sandy Point	4.00	Moderate	Sand	11	Moderate
23	Syphon Creek	0.75	Moderate	Sand-Silt	12	Moderate
24	Pierre's Point	0.05	Sparse	Sand	New	New
25	Glen Echo	0.09	Sparse	Sand-Gravel	13	Present
26	Fraser's Beach	0.25	Sparse	Gravel	New	New
27a	Tappen Bay	1.50	Moderate	Sand	14	Sparse
27b	Tappen Bay	3.50	Sparse	Sand-Clay	14	Sparse
28	Sky Blue Waters	>.01	Present	Gravel	New	New
29	Sunnybrae Point	0.30	Sparse	Sand-Silt	15	Present
30	Sunnybrae Bible Camp	0.30	Sparse	Sand	15	Sparse
31	J.P. Marina/ Herald Prov. Park	0.01	Present	Gravel	New	New
32	Canoe Point	>.01	Present	Gravel	New	New
33	Cinnemousun Narrows	>.01	Present	Gravel	16	Present
	Total	28.02				

*See locations on Figure 9

TABLE 6

SHUSWAP LAKE CONTROL PROGRAM - SUMMARY OF COSTS - 1984

1.	Control Treatments	
1.1	Field Supervisor (salary and benefits)	$ 5 551.64
1.2	Field assistants and transport operator wages	13 747.47
1.3	Contract work	1 047.74
1.4	Payroll overhead (WCB, CP, CIP, etc)	1 066.55
1.5	Vehicle lease	2 608.08*
1.6	Materials, supplies and services	4 676.52
1.7	Provincial Service Contribution	1 202.74
		$29 900.74
2.	Surveillance and Monitoring (Provincial Service contribution)	6 297.26
3.	Public Information	
4.	Administration	
4.1	Accounts and Payroll overhead (cost-shared)	1 140.00
4.2	Accounting and Payroll overhead	581.88**
	TOTAL COST	$37 919.88

* Vehicle lease provided 100% by province

** Accounting and Payroll overhead, 100% service contribution by R.D.C.S.

TABLE 7

SHUSWAP LAKE CONTROL PROGRAM: SUMMARY OF RESULTS 1981 to 1984

	1981	1982	1983	1984
Total Infested Area (ha)	5.95	6.27	15.0	28.02
Number of Sites	9	10	16	33
Area Treated (ha)	5.93	6.27	14.26 (12.76)*	19.86 (15.36)*
Handpicking	-	6.25	3.75	7.60
Bottom barriers	0.06	0.02	0.31	0.03
Diver dredge	5.81	-	-	4.33
Derooting (Cult)	-	-	7.20	1.50
(Roto)	-	-	1.50	6.50
Treatment Cost	$17 000	$ 8 000	$21 500	$29 900.74
Program Cost	18 500	27 000	34 000	37 919.88**
Unit Cost	2 694 .36/ha	4 269.22/ha	2 664.58/ha	1 909.35/ha ($2 468.74)**

* Net area treated

** Including non-cost-shared costs

APPENDIX I

MANAGEMENT OPTIONS FOR CONTROL OF *MYRIOPHYLLUM SPICATUM* L. IN SHUSWAP LAKE - 1985

1. CONTROL OPTIONS AVAILABLE FOR TREATMENT OF *MYRIOPHYLLUM SPICATUM* POPULATIONS 1985

Location	1984 Area Estimate (ha)	Nuisance Potential	Treatment* Options
Sicamous N.	0.50	High	D/H
Sicamous Beach	0.60	High	D/R/Bb
Hotel Site	0.10	Low	D/H/Bb
Silver Sands	0.50	High	R/Hb
Eagle River	3.40	Moderate	D/R
Old Town	0.01	Moderate	D/R/H/Hb
Arms Bay	>.01	Moderate	H
Railway	>.01	Low	H
Wharf	>.01	Moderate	D/H
Mill East	0.25	Low	D/R/Bb
Mill West	0.10	Low	D/R
Canoe Marina	0.10	High	D/R/H/Hb
Canoe Wharf	0.05	High	D/R/H/Bb
Canoe Beach	0.05	High	D/R/H
Captain's Cove	0.50	High	D/Hb/H
Engineers Pt.	0.10	Low	D/H/Bb
Mallard Pt.	0.05	Low	D/H/Bb
Pump House	0.05	Low	D/H/Bb
Mud Bay	4.00	Low	R
Salmon River	1.00	Low	R/Hb
Sandy Beach	1.00	High	D/R/H
Sandy Pt.	8.50	High	R/D
Syphon Creek	0.75	High	D/R
Pierre's Pt.	0.05	High	D/R/Hb/H
Glen Echo	0.09	Moderate	D/R/Hb/H/Bb
Fraser's Beach	0.25	Moderate	D/Hb/H
Tappen Bay	5.00	Low	R
Sky Blue	0.01	Moderate	D/H
Sunnybrae Pt.	0.30	Low	D/R/H
Sunnbrae Bible	0.30	Moderate	D/R/Bb
J.P. Marina	0.01	Moderate	D/H/Bb
Canoe Pt.	>.01	Low	D/H
Cinnemousun	>.01	High	D/H

*Treatment Options

- D - Diver dredging
- R - Rotavation (Derooting)
- H - Handpicking
- Hb - Herbicide
- Bb - Bottom barrier

TABLE 2

INTENSIVE CONTROL OPTION - RECOMMENDED TREATMENT METHODS FOR SHUSWAP LAKE IN 1985

Site Number	Location	Estimated Area (Ha)	Density of *M. spicatum*	Recommended method and reasons for selection, and comments.
1	Sicamous Narrows	0.50	Present	Diver dredging. Plant density very low, scattered in and among marinas in the narrows. Density too low and conditions not suitable for derooting. Plants are growing in areas frequented by boats and on the threshold of Mara Lake, therefore treatment should be very thorough and attempt to remove as much material as possible which can only be accomplished by diver dredging.
2a	Sicamous Beach	0.05	Moderate	Diver Dredging except for 0.15 ha in the vicinity of the mouth of Silver Sands Lagoon (Site 4) which should be rototilled along with Silver Sands. Diver dredging has successfully kept the main portion of the Sicamous Beach and Eagle River sites at a very low density. Initially dredged in 1981, and have required only minimal maintenance since then. Condtions are suitable for diver dredging - good visibility low plant density.
2b	Sicamous Beach	0.55	Present	
5	Eagle River	3.40	Present	
4	Silver Sands Lagoon	0.50	Moderate	Rototilling. Inside the lagoon itself the water becomes stagnant during the summer and it is not safe to expose the divers to this stagnant water for long periods of time - they develop ear infections and other related health problems.
(Part of 2b)	Sicamous Beach	0.15	Present	
3, 6 - 18	All small sites from Sicamous Narrows to past Mallard Point. See Table 1 and Fig. 1	1.74 Total	Single plants, present, sparse, moderate	Diver dredging. A number of widely dispersed very small sites of very low density. Too small and sparse to rototill.
19	Mud Bay	4.00	Present	Diver Dredging. Very low density scattered over a large area. Too low density to rototill. Has the potential to develop into a serious (large and dense) infestation. Should attempt diver dredging to see if the low density can be maintained. If the density increased to uniformly moderate the site will be too large to diver dredge and rototilling will have to be considered.
20	Salmon River	1.00	Moderate clumps	
21a	Sandy Beach	0.75	Present	Diver dredging. Extremely low denisty left after 1984 dredging and hand picking. Relatively small size and low density suitable for dredging.
21b	Sandy Beach	0.25	Sparse	
22a	Sandy Point	4.50	Sparse	Rototilling. Too large and too dense to diver dredge. Rototilled in 1984, should be rototilled again in 1985 very thoroughly to achieve maximum reduction. It may be desirable to use diver dredging to "mop up" remaining very sparse plants sometime in the future.
22b	Sandy Point	4.00	Moderate to dense	
23	Syphon Creek	0.75	Sparse to moderate	
24	Pierre's Point	0.05	Present	Diver dredging. Small patches, low density not sufficiently developed to rototill. Suitable conditions for diver dredging.
25	Glen Echo	0.09	Sparse	
26	Fraser's Beach	0.25	Sparse	
27a	Tappen Bay	1.50	Moderate	Rototilling. Too large and dense for diver dredging.
27b	Tappen Bay	3.50	Sparse	
28	Sky Blue Waters	>.01	Present	Diver dredging. Small patches, low density not sufficiently developed for rototilling. Suitable conditions for diver dredging.
29	Sunnybrae Point	0.30	Sparse	
30	Sunnybrae Bible Camp	0.30	Sparse	Rototilling. Has the potential to expand into a large site, spread out over a wide flat shelf and is therefore more difficult to diver dredge than some of the other sites which may be the same size and density but confined to a long narrow band.
31	J.P. Marina and Herald Park	0.01	Sparse	Diver dredging. Small patches, low density not sufficiently developed for rototilling. Suitable conditions for diver dredging.
32	Canoe Point	>.01	Sparse	
33	Cinnemousin Narrows	>.01	Present	

Total area recommended for Derooting (Rototilling): 15.20 hectares

Total area recommended for Diver Dredging: 12.82 hectares

2.2 INTENSIVE CONTROL OPTION - PROVISIONAL BUDGET

1.	Field Supervisor $12.50/hr x 8 hr/day x 21.75 days/mo x 6 mo.....	$ 13 050.00
2.	Field Assistant $7.42/hr x 8 hr/day x 21.75 days/mo x 60 mo.....	7 746.48
3.	Derooting	
3.1	Operator's Wages $12.83/hr x 8 hr/day x 40 working days.....	4 105.60
3.2	Fuel, Lubricants, Supplies.....	1 000.00
3.3	Transport.....	600.00
3.4	Repairs and Maintenance.....	3 568.40
3.5	Pickup Rental and Operation.....	1 700.00
3.6	TOTAL FOR DEROOTING.....	10 974.00
4.	Diver Dredging	
4.1	Dredge Foreman Wages $11.59/hr x 8 hr x 21.75 days/mo x 7.25 mo.....	14 620.79
4.2	Dredge Crew Wages $10.06/hr x 3 people x 8 hr/day x 21.75 days/mo x 7.25 mo.....	38 072.07
4.3	Dive Premium Pay 4 shifts/day x 4 hr/shift x 10.86/hr x 21.75 days/mo x 7.25 mo.....	27 399.78
4.4	Air $30.00/day x 21.75 days/mo x 7.25 mo.....	4 730.63
4.5	Fuel, Lubricants, Supplies.....	3 262.50
4.6	Repairs and Maintenance.....	10 150.00
4.7	Vehicle	
	Lease $900/mo x 7.25 mo.....	6 525.00
	Operation.....	1 268.75
4.8	Equipment Transport.....	600.00
4.9	TOTAL FOR DIVER DREDGING.....	106 629.52
5.	Provincial Service Contribution.....	7 500.00
6.	PROGRAM TOTAL.....	145 900.00

3. SEMI-INTENSIVE CONTROL OPTION

3.1 RECOMMENDED TREATMENT METHODS FOR THE SEMI-INTENSIVE CONTROL OPTION PROPOSED FOR SHUSWAP LAKE IN 1985

Site	Weedbed No.	Area (ha)	Treatment Methods*
Sicamous Narrows	1	0.50	D/H
Sicamous Beach	2	0.60	D/H
Silver Sands Lagoon	4	0.50	R
Eagle River	5	3.40	D/H
Old Town Bay	6	0.01	D/H
Wharf Pilings	9	0.01	D/H
Canoe Marina	12	0.10	D/H
Canoe Wharf	13	0.05	D/H
Canoe Beach	14	0.05	D/H
Captain's Cove	15	0.50	D/H
Sandy Beach	21	1.00	D
Sandy Point	22	8.50	R
Syphon Creek	23	0.75	D/R
Pierre's Point	24	0.05	D/H
Glen Echo	25	0.09	D/H
Fraser's Beach	26	0.25	D/H
Sky Blue Waters	28	0.01	D/H
Sunnybrae Bible Camp	30	0.30	D/R
J.P. Marine	31	0.01	H
Cinnemousun Narrows	33	0.01	H

*D = Diver dredge
H = Handpick
R = Rotavate

3.2 SEMI-INTENSIVE CONTROL OPTION - PROVISIONAL BUDGET

3.2.1	Derooting 9.75 ha, 6 weeks operation	$21 000*
3.2.2	Diver dredging 6.94 ha 6 weeks operation	22 500*
3.2.3	Provincial service contribution - surveying, monitoring, technical assistance, evaluation	7 500
		$51 000

*RDCS Field Supervisor's wage included

4. COSMETIC CONTROL PROGRAM OPTION

No program required in 1985.